

Unit #2

Intro to Chemistry, Branches of Chem., Scientific Method, & Matter.

Instructor's notes

Intro to Chemistry

1. **Alchemy**- Ancient practice in which the "scientist" attempted to turn common metals into gold. WE KNOW THIS IS IMPOSSIBLE, but they did not. However, they did help science in that they discovered chemicals, designed lab equipment, and even "discovered" how to separate mixtures by distillation and sublimation.
2. **Chemistry**- The study of the composition of substances and the changes they undergo.
3. **Antoine Lavoiser**- "Father" of modern chemistry. He made and recorded changes of mass during chemical reactions.
4. Chemistry is all around us. You live with it and its products on a daily basis.
 - a) Can you think of any examples?
 - i) Synthetic shirt fibers
 - ii) Clothing dyes
 - iii) Hair coloring
 - iv) Nail polish remover
 - v) Soaps
 - vi) Calculators
 - vii) Crude oil and its derivatives.
 - viii) Many others...
5. Major Branches of Chemistry.
 - a) **Organic Chemistry**- the study of essentially all substances containing carbon; deals with the "SPONCH" elements.
 - i) SPONCH- an acronym made of the element symbols of: Sulfur, Phosphorus, Oxygen, Nitrogen, Carbon, & Hydrogen.
 - ii) Examples: synthetic fibers, non-stick cooking surfaces, Teflon, tires.
 - iii) Often used by: Chemical engineers (creators of tire compounds, insecticides, synthetic lubricants...), Lab technicians, Medicine inventors...
 - b) **Physical Chemistry**- the study of chemicals and the changes in energy as they undergo reactions and processes.
 - i) Examples: balloons, automobile engineers, explosive designers
 - ii) Energy = 1. work, 2. heat, 3. entropy ~ vibration and wasted energy (disorder).

- c) **Inorganic Chemistry**- the study of substances without carbon; mainly from non-living things.
 - i) Minerals, gemology, steel making, alloys, generally NOT "SPONCH".
- d) **Analytical Chemistry**- concerned with the composition of substances. There are two types: Qualitative and Quantitative.
 - i) Examples: Soil testing, water testing, blood analysis.
 - ii) Qualitative- determines if a substance is present by testing for its characteristic reactions with certain substances.
 - iii) Quantitative- determines how much of a substance is present; its quantity; ("Percent composition").
- e) **Biochemistry**- the study of the chemistry of living things and their processes.
 - i) Examples: Photosynthesis, respiration, marine biology, digestion, bio-warfare, WMD (biological or chemical).

6. How does Chemistry relate to other natural sciences?

- a) **Geology**- the study of the earth.
 - i) Petroleum, distillation of crude oil, mining and how much sulfur may be in the coal.
- b) **Biology / Physiology**- the study of life & the body.
 - i) How body processes function, detoxification of poisons (including medicines), respiration, and photosynthesis.
- c) **Physics**- study of energy and forces.
 - i) Electronics, circuit boards, computer chips, diodes...

7. Two types of Chemistry:

- a) **Pure Chemistry**- knowledge is accumulated for its own sake; neither good nor bad.
 - i) Chemical reactions, how much, what is it, color?, texture...
- b) **Applied Chemistry**- knowledge is either used to benefit or harm people or the environment.
 - i) Medicine, chemical warfare, cloning.

The Scientific Method

8. **Scientific Method**- a series of steps used to solve problems.
9. 5 steps of the Scientific Method:
 - a) *Observe the problem*. "What's wrong?"
 - b) *Hypothesize* the reason. Ask questions to find out why there is a problem.
 - c) *Experiment*. To test your hypothesis.
 - d) *Analyze*. Did the experiment prove your hypothesis correct? If not... go back to the hypothesis step.
 - e) *Conclude / Theorize*. Conclude why the problem occurred.
10. Theory vs. Law:
 - a) **Theory**- a thoroughly tested explanation of why experiments give certain results.
 - b) **Law**- a concise statement that summarizes the results of a broad spectrum of observations and experiments.
 - c) What is the difference between a theory and a law? **A theory explains why experiments give results. A law describes the results of observations.**

Matter

11. **Matter**- anything that takes up space and has a mass.
12. **Mass**- amount of matter in an object.
13. **Weight**- effect of gravity on matter.
14. What is the difference between mass and weight? **Assume a jar of peanut butter weighs 600 g. (1.32 pound) on earth. The moon's gravity is 1/6th that of the earth's; therefore the same jar would weigh only 100 g. (0.22 pound) on the moon. That is weight. However, did the mass change ? (Assume it was never opened.) No. That is mass (the amount of matter).**
15. All matter belongs to one of two groups of matter:
 - a) **Heterogeneous matter**- different or not uniform in composition; each type of substance retains its own unique properties, and each can be separated from the other by ordinary chemical means. These are all mixtures.
 - i) Examples: M&Ms, tossed salad, Lucky Charms, Jell-O fruit salad.
 - b) **Homogeneous matter**- uniform in composition.
 - i) Examples: Oxygen, water, salt water, kool-aid, Aluminum, Iron, Carbon dioxide, tomato soup, juice. These may be either mixtures (specifically solutions) or pure substances.
 - c) **Mixtures**- may be either heterogeneous or homogeneous. (They are a physical blend of two or more substances.)

16. All homogeneous matter belongs to one of two groups:

- a) **Pure substances-** particular kind of matter with a definite and uniform composition.
 - i) Examples: Water, CO₂, Oxygen, Lead, Americium.
- b) **Solutions-** homogeneous mixtures.
 - i) Examples: salt water, orange juice...
 - ii) Solutions have phases that are either solid, liquid, gas, or a combination of the three.
 - iii) They are always listed with the lesser constituent first.
 - iv) All solutions are a mixture of the solute and solvent.
 - (1) **Solute-** the substance that is dissolved. It is the lesser constituent by volume.
(Ex: The salt in salt water)
 - (2) **Solvent-** the substance that does the dissolving. It is the greater constituent by volume. (Ex: The water in salt water)
- c) There are 6 types of solutions based on the phases of their components.
 - i) Gas - Gas: air
 - ii) Liquid - Gas: water vapor
 - iii) Gas - Liquid CO₂ in water
 - iv) Liquid - Liquid 2 Stroke fuel (oil in gas)
 - v) Solid - Liquid salt water, Kool-aid
 - vi) Solid - Solid Alloys, Sterling silver.
- d) A homogeneous solution has only one phase, while a heterogeneous solution has 2 or more phases. (Vinegar & Oil).
- e) All pure substances belong to one of two groups:
 - i) **Elements-** a substance that cannot be decomposed by ordinary physical or chemical means, under normal laboratory conditions. Each has its own unique and identifiable characteristics. **Examples: Anything on the Periodic Table of the Elements.**

There are two main groups of elements:

- (1) **Metals-** usually solid / liquid at room temperature, good conductors of heat and electricity, malleable, ductile, often shiny (luster).
Examples: Magnesium, Sodium, Iron.
- (2) **Non-metals-** may be either solid, liquid, or gaseous, poor conductors of heat and electricity, brittle, often dull.
Examples: Argon, Sulfur, Iodine

Two specific types of non-metals are:

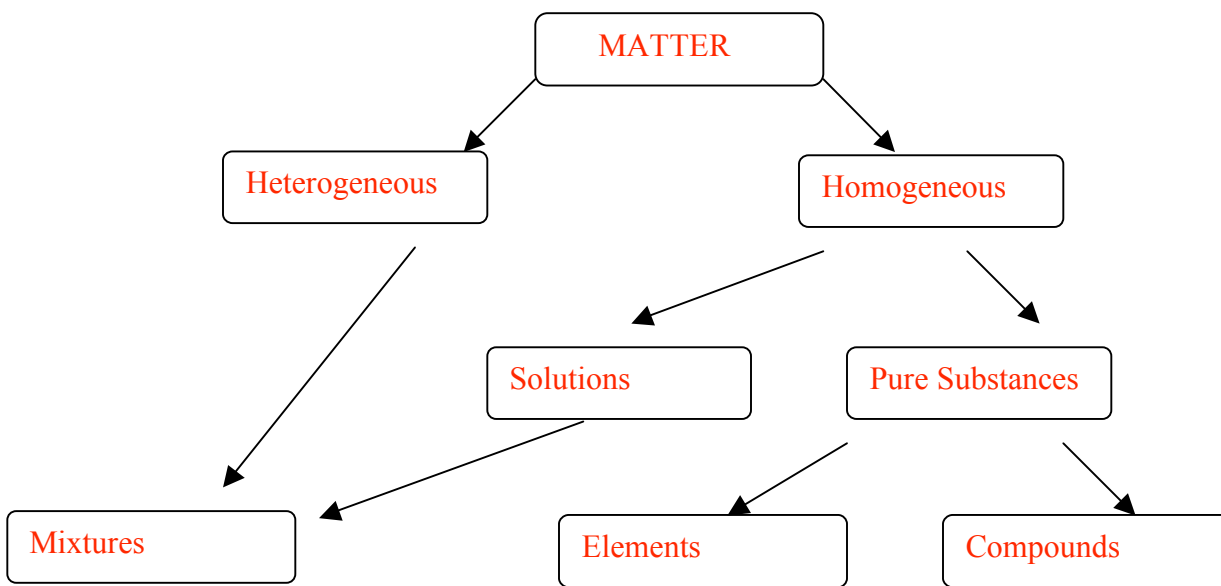
- (a) **Metalloids-** non-metals with some metal like properties. Often used in electronics.
Examples: Silicon, Arsenic, Boron
- (b) **Gases-** Are "gases". Have no definite shape or volume, are fluid (they "flow").
Examples: Oxygen, Helium, Radon

- ii) **Compound**- chemical combination of elements. Each has its own unique and identifiable characteristics. Cannot be separated by physical means. Can be separated by chemical means. **Example: Na is explosive when wet. Cl₂ is a poisonous gas. When combined, they produce the compound known as "table salt".**

(1) **Law of Definite Composition**- All compounds have a definite composition by mass.

Example: Water has a mass of 18g. / mole. Of those 18 grams, 11.1% are always from the Hydrogen; the remaining 88.9% are from the Oxygen.

. **Complete the chart below.**

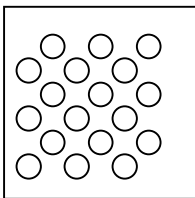


- 17) **Physical property**- quality or condition of a substance that can be observed or measured without changing its composition. The value does not change with the amount of substance.
Examples: Density, Boiling / Condensation point, Melting / freezing point, color, state, odor, texture, solubility, hardness.
- 18) **Chemical property**- The ability of a substance to undergo a chemical reaction (a change) and form a new substance with new, unique properties.
- 19) **Physical change**- altering a substance without changing its composition, physical or chemical properties.
Example: Grinding, melting, freezing, boiling, chopping.
- 20) **Chemical change**- alters a substance by changing its composition.
Example: Combustion of hydrogen to produce water, oxidation of iron to make "rust", decomposition of carbonic acid to make water and CO₂.

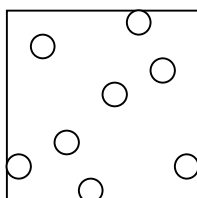
21) States of Matter.

- a) **Solid**- matter with a definite shape and volume. (Low energy and entropy).
- b) **Liquid**- matter without a definite shape, has a definite volume, "flows", takes the shape of the container as it fills it from the bottom up. ("Moderate" energy & entropy).
- c) **Gas**- Matter without a definite shape or volume. (High energy & entropy).

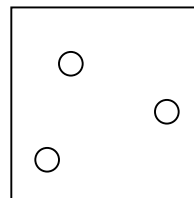
Identify each drawing below as either a solid, liquid, or gas.



Solid



Liquid



Gas

d) Fluid vs. a Liquid.

- i) **Fluid**- any matter that flows. Includes both liquids and gases.
- ii) **Liquid**- see definition above. Does not include gases.

Fluid

Hg
H₂O
HCl (aq)
Air
He
Ne
Xe

Liquid

Hg
H₂O
HCl (aq)

e) Vapor vs. a gas.

- i) **Vapor**- describes a substance that although is in a gaseous state (like a gas), is either a liquid or a solid at room temperature.
Examples: steam, sodium vapor in street lights, Xenon vapor in HID headlamps, gasoline vapor in an internal combustion engine.
- ii) **Gas**- see definition above.

Gas

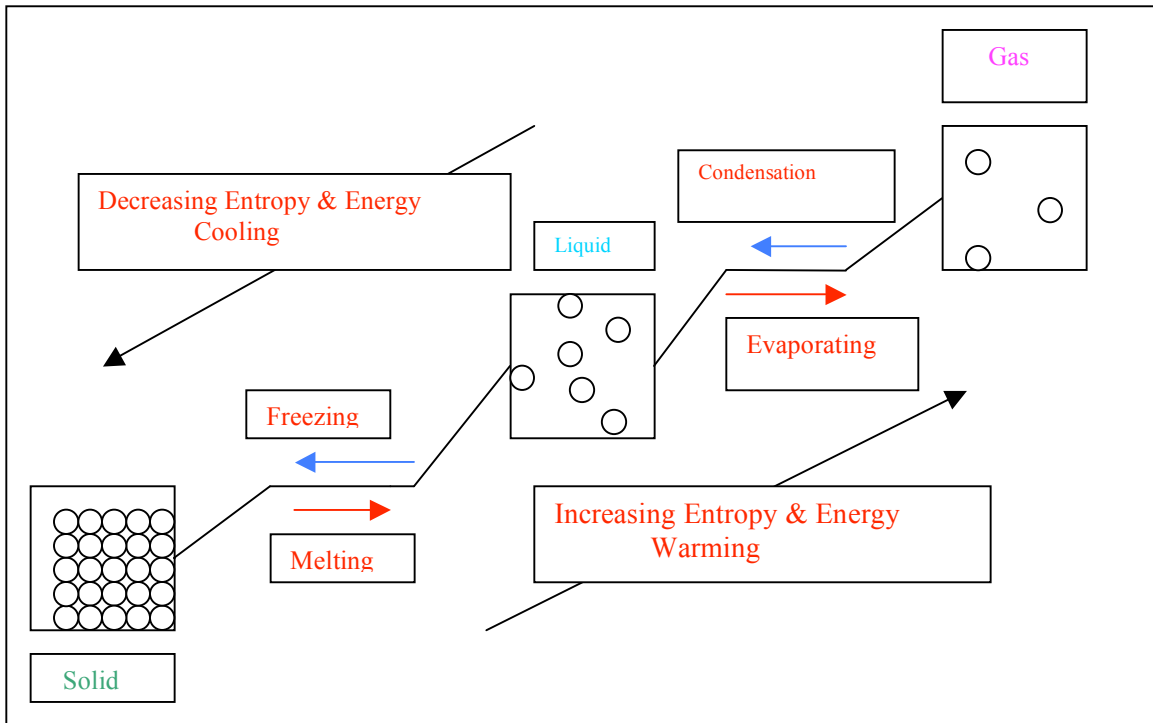
Oxygen
H₂
He
Ne

Vapor

H₂O / Fog / Steam
Hg
Na
NH₄Cl (when sublimed)

- 22) Processes in nature are driven two ways:
- a) Toward lowest energy.
 - b) Toward greatest entropy.
 - i) **Entropy**- amount of disorder in a system.

Consider the following diagram:



Real life example: On September 11th, 2001; terrorist attacked the World Trade Center.

Explain how the above statement could explain the effectiveness at bringing down the Twin Towers. Consider energy and entropy, both before and after the attack.

Answer: When standing there is a great amount of order (very little disorder); processes in nature move toward greater entropy (a lot of disorder). Therefore nature wants the towers to come down.

It required a great amount of energy to erect the towers. This energy remains as stored energy in the "highly stacked building materials". Processes in nature move toward lowest energy (hot things cool, coasting things stop, balls roll down hill). Therefore nature wants the buildings to come down.

Nature was assisted by the terrorists in achieving her ultimate goals.